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(54) Title: OXYGEN-FREE COPPER ALLOY AND METHOD FOR ITS MANUFACTURE AND USE OF COPPER ALLOY

(57) Abstract: The invention relates to an oxygen-free copper alloy containing magnesium between 30 - 180 ppm, preferably 50 - 150 ppm in order to improve temperature resistance. The invention also relates to a method for the manufacture of the copper alloy and to the use of the copper alloy.



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OXYGEN-FREE COPPER ALLOY AND METHOD FOR ITS MANUFACTURE AND USE OF COPPER ALLOY

The invention relates to an oxygen-free copper alloy, in which there is alloyed material that increases temperature resistance. The alloy is particularly suited to be used in targets where both a good temperature resistance and a good electroconductivity is required of the alloy. The invention also relates to manufacturing the copper alloy and to the use of the copper alloy.

The oxygen content of the most generally used copper quality, so-called ETP copper (electrolytic tough pitch) is typically 200 – 400 ppm. Oxygen is naturally bound in copper in a regular manufacturing process. The oxygen content can also be kept on a desired level intentionally, because oxygen bounds harmful substances to less harmful oxides. The electroconductivity of copper is always the higher, the purer the copper is, and also the oxygen bound in copper reduces conductivity. The thermal conductivity of copper is proportional to its electroconductivity. Particularly for improving the electroconductivity, there is also manufactured so-called oxygen-free copper with an oxygen content not higher than 10 ppm. In the manufacturing of oxygen-free copper, oxygen is prevented from getting into contact with molten copper by using a protective, reducing layer on top of the melt (for example graphite), by using protective gas (for example nitrogen) or by using a vacuum.

The temperature resistance of oxygen-free copper has been improved by alloying silver in the copper, for example 0.02 – 0.3% of the alloy weight. Also magnesium has earlier been used as a microalloying ingredient, generally in very small contents. Other alloy ingredients are generally used at the same time. For example in the publications US-5118470, JP-A-62080241 and JP-A-03291340, there are described these types of alloys, which are used for producing connector wire employed in semiconductor technology. By melting, the wire is formed into drops that have a perfect ball shape. Said material also has a good tensile strength. Apart from other materials, magnesium is

The half-softening temperatures of copper alloys according to the invention are at least of the same order as those of alloys containing 0.3 – 0.25% silver. With a 40% degree of deformation, the half-softening temperature is at least 340° C, preferably at least 380° C. With a 94% degree of deformation, the half-softening temperature is at least 300° C, preferably at least 335° C. Irrespective of alloying, the electroconductivity still remains on a high level (over 100 % IACS). Conductivity is preferably at least about 101 % IACS.

With contents over 180 ppm, the improving of the temperature resistance with respect to the magnesium quantity is essentially weakened. Also electroconductivity and castability are weakened. With magnesium contents of less than 30 ppm, essential improvements in the temperature resistance are virtually not achieved.

Here magnesium raises the recrystallization temperature of pure copper. Magnesium atoms are larger than copper atoms, wherefore the lattice structure is distorted, and tensions are created. Consequently the moving of dislocations becomes more difficult.

By means of the invention, there are reached savings in expenses in comparison with the use of silver, because magnesium is remarkably cheaper than silver, and it is needed in a remarkably smaller quantity than silver. Owing to the small quantity of alloy ingredient, also the alloying technique can be chosen more freely.

Magnesium alloyed copper can be manufactured by similar manufacturing techniques as other qualities of oxygen-free copper, for example in slab or rod casting, either as horizontal or vertical casting. In a suitable step of the process, for instance into the casting furnace, there is added a required amount of magnesium. Because magnesium is sensitive to react with oxygen, especial attention must be paid to protection from air. Also in devices that get into

Example

There were manufactured magnesium alloyed oxygen-free copper alloys, in which there were alloyed magnesium 50, 100 and 150 ppm of the alloy weight.

- i The temperature resistance and electroconductivity of the alloys were compared with the temperature resistance and electroconductivity of known silver-copper alloys.

An annealed wire of 8 mm was manufactured of each material. The electroconductivity of the wire was measured. Thereafter the wires were drawn to the thickness of 6.2 mm (degree of deformation 40%) or 2 mm (degree of deformation 94%). The wires were annealed in a salt bath (1 h) within the range of 250 – 500° C. The results are given in the table below in which table for instance the marking Mg50ppm means the alloy of the invention, which contains 50 ppm magnesium, and the marking CuAg0.03 means the copper alloy of the prior art which contains 0.027 – 0.05 % by weight silver.

| Alloy | Ag [% by weight] | Electroconductivity [%IACS] | T½ 40% [°C] | T½ 94% [°C] |
|----------|------------------|--------------------------------|----------------|----------------|
| CuAg0,03 | 0,027-0,05 | 100,88 | 340 | 295 |
| CuAg0,1 | 0,085-0,12 | 100,77 | 360 | 325 |
| CuAg0,2 | 0,20-0,25 | 101,10 | 380 | 340 |
| Mg50ppm | - | 101,95 | 363 | 310 |
| Mg100ppm | - | 101,40 | 379 | 335 |
| Mg150ppm | - | 100,84 | 386 | 340 |

It is apparent that with magnesium contents of 50 – 150 ppm, there are achieved properties that are at least as good as with silver contents of 0.027 – 0.25%.

9. A method for manufacturing oxygen-free copper alloy, said alloy containing oxygen not more than 10 ppm, **characterized** in that magnesium is alloyed in the alloy for over 30 ppm, but not more than 180 ppm of the alloy weight.
10. The use of copper manufactured according to any of the claims 1 – 8 or according to claim 9 in a product where there is required a good temperature resistance and a good electroconductivity or thermal conductivity.
11. The use of the claim 10 in commutators of electric motors.
12. The use of the claim 10 in a tip of a welding electrode.
13. The use of the claim 10 in generator profiles.
14. The use of the claim 10 in generator flat bars.